Nanostructured Photovoltaics for Space Power

Completed Technology Project (2012 - 2015)

Project Introduction

The NASA NSTRF proposal entitled Nanostructured Photovoltaics for Space Power is targeted towards research to improve the current state of the art photovoltaic technology. A quantum dot nipi doping superlattice cell will be pursued with the objective of realizing an intermediate band solar cell (IBSC). The nipi structure is a novel design that depends on multiple n-type / intrinsic / p-type / intrinsic repeat units. Due to the multiple quantum wells formed through the thickness of the novel structure, lateral contacts are required, which can be made via epitaxial regrowth. With high doping levels, and close spacing between doped layers, quantum confinement occurs within the superlattice. This confinement creates states through which lower energy photons will be absorbed, although the unconfined bulk material is transparent at these energies. An additional benefit of the tightly spaced doped layers is that the entire region will be drift field dominated, and carriers will not be lost due to recombination prior to the much slower diffusion processes. This drift field dependence allows quantum dots to be located at any location within the device, while still allowing the carriers to be quickly extracted. This freedom in locating the quantum dots will allow them to be doped in such a way as to be half filled with carriers, which is an essential requirement for the IBSC. With the realization of the IBSC, efficiency increases will be seen, with the possibility of reaching 46% under one sun AM0 illumination. The high efficiency that is attainable for this device structure will provide dramatic improvements in mass specific power, reaching 1169.9 W/kg at the cell level, which exceeds the NASA metric of 500 W/kg. Due to the drift field dominated device, a substantial boost to the radiation tolerance in the device is achieved, since a decrease in diffusion length will not negatively affect carrier collection. Radiation tolerance has been shown to improve for a nipi device, where the expected lifetime is 11.9 times greater than a single junction GaAs device, making it a good choice for the high radiation doses possible in space. The radiation tolerance, along with the ability to collect carriers efficiently through drift mechanisms instead of diffusion allows the design to function well for the high concentrations experienced in near sun missions. The work to realize the IBSC with the quantum dot nipi solar cell can be realized via a partnership between RIT and the NASA Glenn Research Center. Significant accomplishments have already been seen through this partnership, some of which include the development of high quality quantum dots, nanowires, the preliminary work related to the nipi structure and the evaluation of the regrowth process. This partnership can be furthered through the NSTRF fellowship, and the synergies that will be created as RIT students interact more closely with the highly skilled NASA staff.

Anticipated Benefits

The high efficiency that is attainable for this device structure will provide dramatic improvements in mass specific power, reaching 1169.9 W/kg at the cell level, which exceeds the NASA metric of 500 W/kg. Due to the drift field

Project Image Nanostructured Photovoltaics for Space Power

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Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Responsible Program:

Space Technology Research Grants

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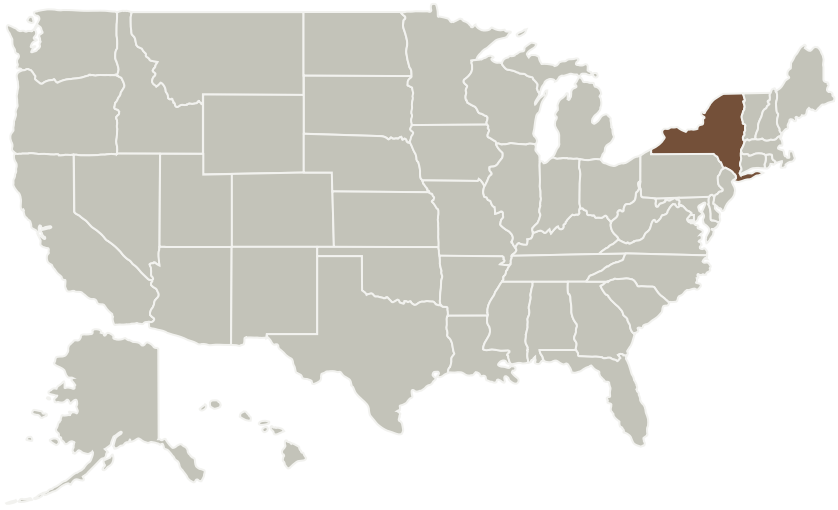
Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
Rochester Institute of Technology(RIT)	Supporting Organization	Academia	Rochester, New York

Primary U.S. Work Locations
New York

Project Management

Program Director:
Claudia M Meyer

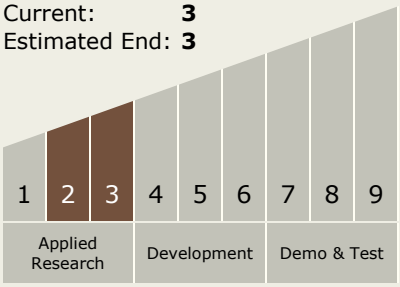
Program Manager:
Hung D Nguyen

Principal Investigator:
Seth M Hubbard

Co-Investigator:
Michael A Slocum

Technology Maturity (TRL)

Start: **2**
Current: **3**
Estimated End: **3**



Technology Areas

Primary:

- TX10 Autonomous Systems
  - TX10.3 Collaboration and Interaction
    - TX10.3.4 Operational Trust Building

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Images

11538-1363198115452.jpg
Project Image Nanostructured Photovoltaics for Space Power
(https://techport.nasa.gov/image/1803)

Project Website:

https://www.nasa.gov/directorates/spacetech/home/index.html